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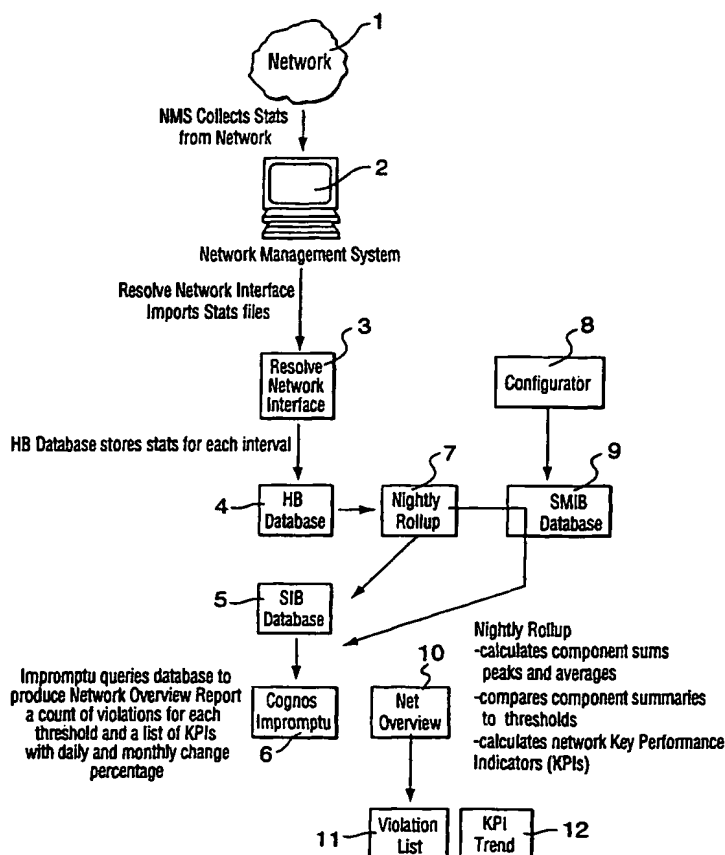
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[Continued on next page]

(54) Title: NETWORK OVERVIEW REPORT



(57) Abstract: A method of identifying and locating performance issues in multi-technology wide area networks, involves monitoring individual components in the network to identify specific components whose performance has fallen below a predetermined threshold, and monitoring the aggregate performance of the network to create key performance indicators (KPIs) representative of the performance of the network as a whole. The threshold crossings and KPIs are displayed in a network overview report.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Network Overview Report

This invention relates to digital communications networks, and in particular to a method of identifying and locating performance issues in multi-technology wide area networks.

- 5 In multi-technology wide area networks, such as Asynchronous Transfer Mode (ATM), Frame Relay (FR), Time Division Multiplexing (TDM) and Internet Protocol (IP) telecommunication networks, problems inevitably arise in the operation of the network. Operators typically identify network problems in one of two ways: a customer either notifies them of a problem and they run
10 performance reports on individual components until they identify the problematic component, or else a network element itself sends an alarm.

The first method has two problems: service providers need to know about the problems before their customers, and in order to isolate the problem they must run all reports that might be affected. This is very time-consuming.

- 15 Network Element alarms are also of limited use. In many situations the initial problem disables the element, so that it cannot send an alarm. Alarms are usually also limited to availability problems, not performance degradation.

An object of the invention is to alleviate this problem.

- According to the present invention there is provided a method of identifying and
20 locating performance issues in multi-technology wide area networks.

- Performance data is continually received from individual elements of the network, said data is stored in a database, specific elements whose performance has fallen below a predetermined threshold are identified, the aggregate
performance of the network is monitored to create key performance indicators
25 (KPIs) representative of the performance of the network as a whole, and a network overview report is electronically generated to display the threshold crossings and KPIs for the network.

The Network Overview Report is designed specifically, but not necessarily exclusively, for use with Asynchronous Transfer Mode (ATM), Frame Relay (FR),

Time Division Multiplexing (TDM) and Internet Protocol (IP) telecommunication networks.

The Network Overview report typically uses two types of network metrics to identify network performance problems. Network Thresholds identify specific problematic components (circuits, facilities, nodes, ports and access points).
5 Network Key Performance Indicators (KPIs) identify problems that are endemic to the entire network.

Network Thresholds identify specific components whose performance has fallen below prescribed levels. The Network Overview report displays a count of all
10 components that have violated a threshold. Each threshold can have multiple levels corresponding to different degrees of seriousness, for example, limited, minor, major, and critical.

Users can then view the components that violated that threshold and the time they did so by clicking on the hyperlink representing the threshold name.

15 Key Performance Indicators (KPIs) track the aggregate performance of the entire network and highlight problems that cannot be solely attributed to a few faulty components, but are also due to systemic problems throughout the network. The Network Overview shows the KPI value for the previous day and compares it to the same day of the previous week and the previous month's average. Changes
20 of more than 10 and 20% are highlighted to help operators quickly identify significant movers. Users can view a graphical trend of this KPI for the last 60 to 90 days by clicking on the KPI name.

The information is collected in a Data Management Framework, which may, for example, be a Resolve™ system from Crosskeys Systems Corporation. This
25 calculates KPIs and Network Threshold Violations based on data collected from the network. The KPIs and Threshold information is stored in a Summarized Information Base (SIB). The Network Overview report can be generated from this information at any time, either by user request or automated on a scheduled basis.

The invention also provides a network monitoring system for a network having a network management system and a plurality of managed elements, characterized in that it comprises a database for receiving and storing performance data relating to the operation of network elements from said managed elements, and a
5 computer-implemented analysis tool for analyzing said data in said database to identify specific elements whose performance has fallen below a predetermined threshold and create key performance indicators (KPIs) representative of the performance of the network as a whole, and a display for displaying the threshold crossings and KPIs for the network created by said analysis tool.

10 The invention will now be described in more detail, by way of example only, with reference to the accompanying drawings, in which:-

Figure 1 is a simplified diagram of a digital communications network and management system;

Figure 2 is a schematic diagram showing the logical structure of a network
15 service level manager; and

Figure 3 shows a network overview report generated by the invention.

Referring now to Figure 1, a digital communications network 1 containing multiple network nodes constituting managed elements is connected to a network management system 2, which controls the operation of the network 1.

20 The network 1 could, for example, be an ATM network. The network management system 2 is responsible for the physical control of the network 1, for example, setting up virtual connections within the network and otherwise controlling operation of network elements.

In addition to controlling the operation of the network, the network operator
25 must be able to monitor its performance, for example, to ensure that customers are receiving the level of service that they have subscribed to. Crosskeys Systems Corporation Resolve™ interface 3 is connected to the network management system 2 and extracts and stores data pertaining to the performance of the network and provides the operator with detailed performance-related statistics.

The Resolve™ system extracts huge amounts of data from the network since it continually monitors each network element and each virtual channel set up within the network. These network statistics are stored in the HIB (Historical Information) database 4.

- 5 Each night nightly roll-up component 5 calculates the sums, peaks and averages of traffic for the network components, compares the component summaries to predetermined thresholds, counts the violations for each threshold, and calculates network key performance indicators, KPIs. These give performance criteria based on the sum, average, or weighted average of the statistics from all
10 the network components.

The data from the nightly roll-up component 5 is passed to the SMIB database 9. The configurator 8 allows the user to set the network thresholds in the SMIB 9. The nightly roll-up unit 5 and SMIB database 9 supply data to the SIB (Summary Information) database 10.

- 15 The detailed structure of the Resolve™ system is shown in more detail in Figure 2. In this embodiment, the detailed statistics are taken from a Newbridge Networks Corporation 46020 network manager and transferred to the database bank 20 by components forming the network interface 3. The database bank is connected to configurator client 8, reporter client, 21, and web reporter server 22.
20 The configurator 8 permits the operator to set the network performance performance criteria, such as thresholds and the like.

When it is desired to obtain an overview report, the SIB database 10 is queried using Cognos Impromptu™ software 11, which provides an SQL graphical reporting tool. This software is commercially available from Cognos Corporation.

- 25 Impromptu™ is a tool that allows users to create systems of reports through sub-reports and report-to-report drill-through from large databases. Reports can be based on multiple linked or unlinked queries.

At the request of a user, Impromptu™ queries the SIB database 10 to produce the network overview report shown in Figure 3. This consists of a count of threshold violations and a list of KPIs with daily and monthly change percentage.

Using the Impromptu™ software, the user can access the network overview
5 report on screen 12 to drill down from the summary information initially present through hyperlinks for details in the violation list 13 or KPI trend 14.

For example, Figure 3 shows how using the Impromptu software™ the user can generate the daily network overview, which gives a convenient summary of the status of the network. The threshold violations for all components in the network
10 are shown in list 30. For example, entry 31 shows two critical occurrences of frame relay PVCs (Permanent Virtual Connections) discarding frames above the permissible threshold. By clicking on the hyperlink, the user can drill down to identify the specific PVCs involved and obtain more detailed information pertaining to the PVCs in question for use in fault analysis. List 30 is useful for
15 fault analysis and correcting specific faults occurring in the network, or possibly rerouting paths so as to avoid bottlenecks.

List 31 shows the key performance indicators (KPIs) which are representative of overall performance on the network. The KPIs are useful for long-term planning. For example, entry 33 shows the overall ATM booked capacity on the network. If
20 this is consistently too high, consideration needs to be given to increasing the capacity of the network.

As in the case of the thresholds, by clicking on the hyperlinks displayed on the screen, the operator can drill down through multi levels using the Impromptu software to obtain more details about the KPI data. For instance, the operator can
25 produce a trend chart showing the overall historical performance of the specific KPI.

The software can also monitor violations of service level agreements with customers and identify problem areas.

I claim:

1. A method of identifying and locating performance issues in multi-technology wide area networks, characterized in that performance data is continually received from individual elements of the network, said data is stored in a database, specific elements whose performance has fallen below a predetermined threshold are identified, the aggregate performance of the network is monitored to create key performance indicators (KPIs) representative of the performance of the network as a whole, and a network overview report is electronically generated to display the threshold crossings and KPIs for the network.
2. A method as claimed in claim 1, characterized in that said report is displayed on a computer screen using a graphical SQL reporting tool.
3. A method as claimed in claim 2, characterized in that said reporting tool provides access to more detailed information through hyperlinks about network performance.
4. A method as claimed in claim 3, characterized in that said reporting tool permits the user to drill down through the data using said hyperlinks to obtain progressively more detailed statistical information about the network elements.
5. A method as claimed in claim 4, further comprising the step of monitoring service level agreement violations using said network overview report.
6. A method as claimed in claim 5, characterized in that said KPIs represent the sum, average or weighted average of statistics relating to performance of network components.
7. A method as claimed in claim 1, characterized in that said database is part of a data management framework for the network.
8. A method as claimed in claim 1, wherein at predetermined periods, the sums, peaks and average of traffic for managed elements are calculated to determine KPIs.

9. A network monitoring system for a network having a network management system and a plurality of managed elements, characterized in that it comprises a database for receiving and storing performance data relating to the operation of network elements from said managed elements, and a computer-
- 5 implemented analysis tool for analyzing said data in said database to identify specific elements whose performance has fallen below a predetermined threshold and create key performance indicators (KPIs) representative of the performance of the network as a whole, and a display for displaying the threshold crossings and KPIs for the network created by said analysis tool.
- 10 10. A network monitoring system as claimed in claim 9, characterized in that said database is connected to a calculation unit that calculates the sums, peaks and averages of traffic for said managed network elements on a periodic basis.
11. A network monitoring system as claimed in claim 10, characterized in that said display includes hyperlinks to permit more detailed information about the
- 15 data to be accessed.
12. A network monitoring system as claimed in claim 9, characterized in that said analysis tool is an SQL-reporting tool.

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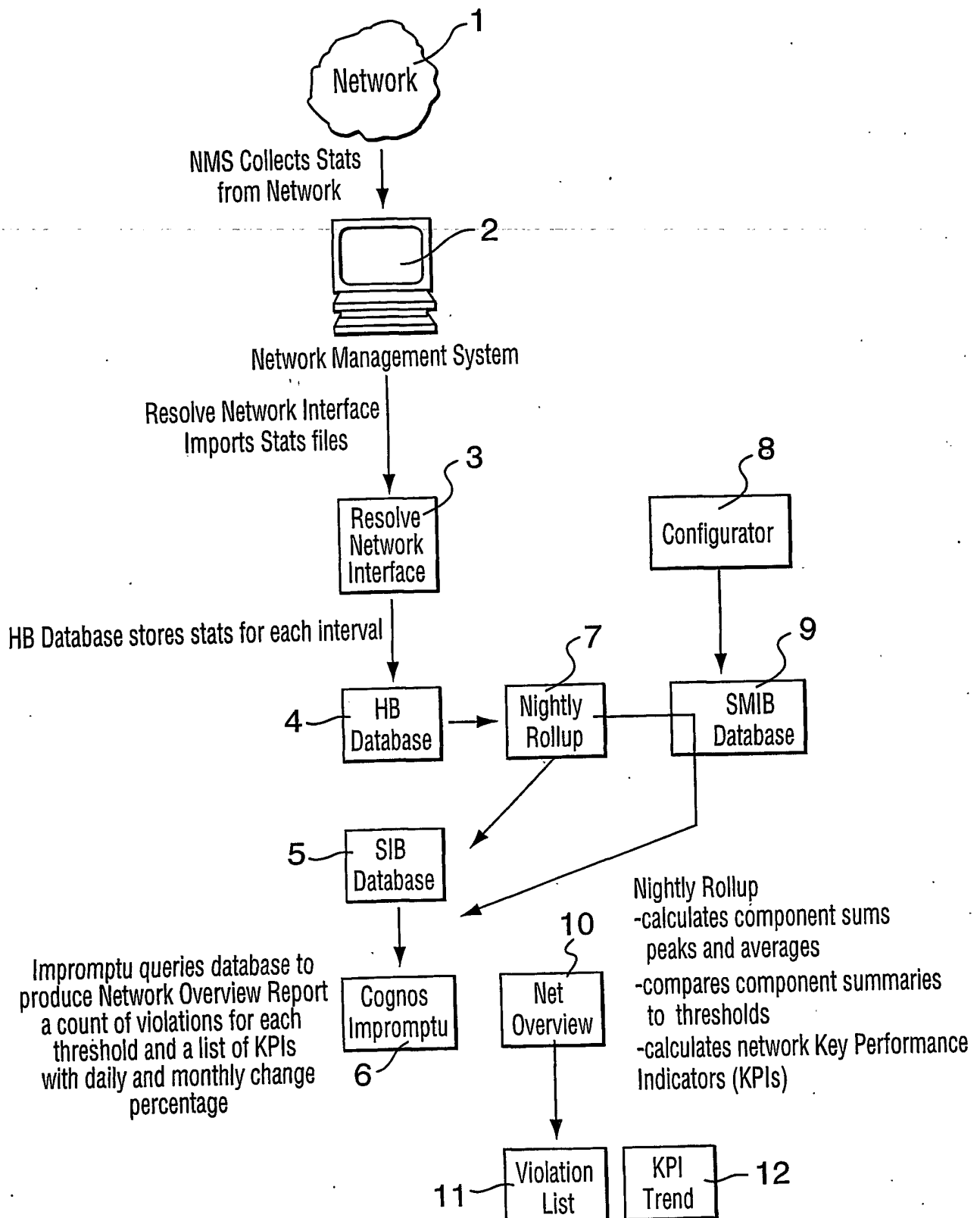


FIG. 1

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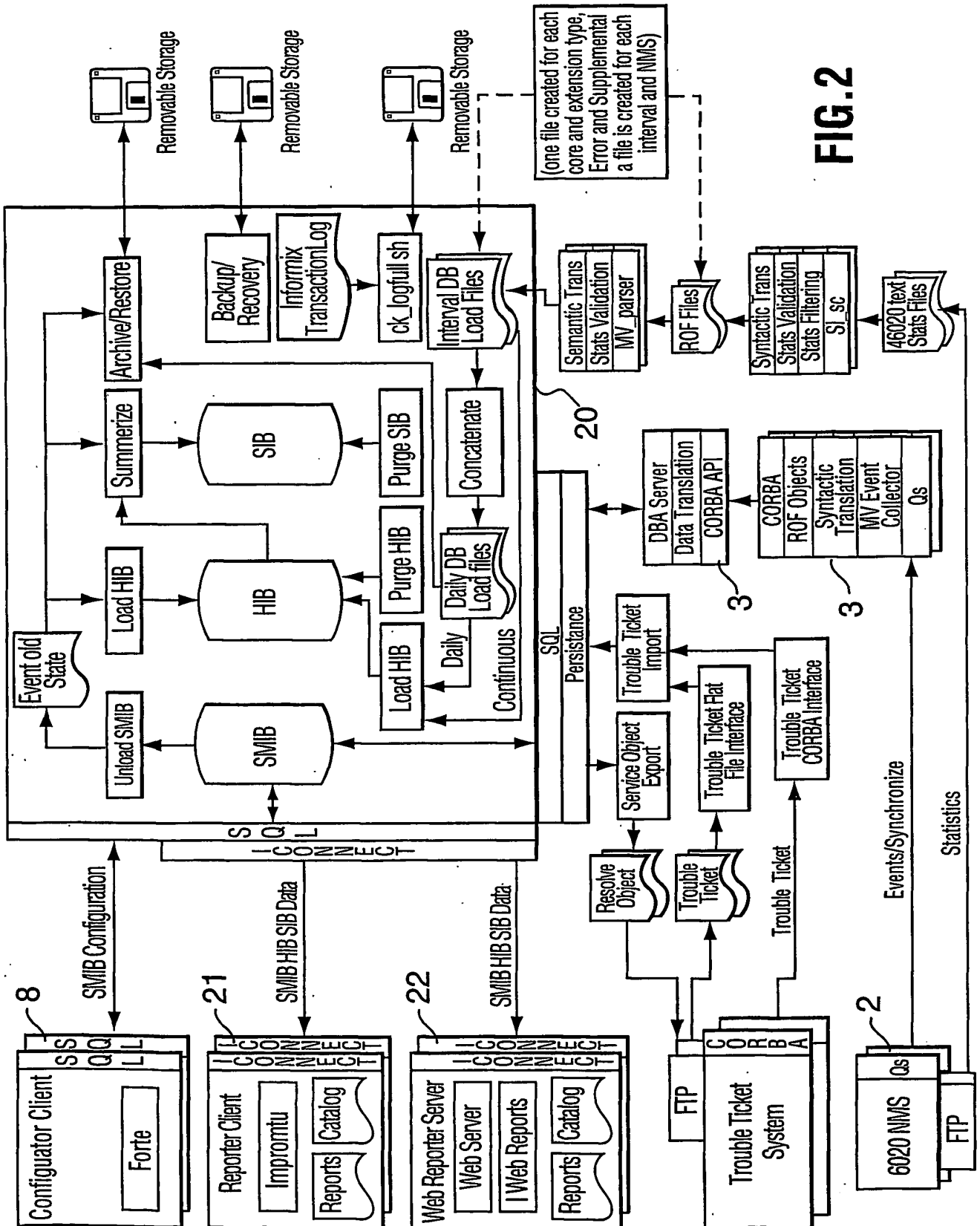


FIG. 2

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Daily Network Overview

Date: Feb 28 1999 Network: Group1

Threshold Crossings

| Threshold Name | Critical | Major | Minor | Warning |
|---|----------|-------|-------|---------|
| ATM Access Point Utilization Threshold | 0 | 0 | 0 | 1 |
| ATM PVC Discarded Cell % Threshold | 0 | 0 | 0 | 1 |
| ATM PVC Utilization Threshold | 0 | 0 | 0 | 1 |
| FR Access Point Availability Threshold | 0 | 0 | 0 | 1 |
| FR Access Point Booked Capacity Threshold | 0 | 0 | 1 | 1 |
| FR Access Point Utilization Threshold | 0 | 0 | 0 | 1 |
| FR PVC Discarded Frame % Threshold | 2 | 3 | 3 | 4 |
| FR PVC Ingress Frames DE Set % Threshold | 0 | 1 | 3 | 3 |
| FR PVC Utilization Threshold | 0 | 0 | 1 | 2 |

Peak Intervals and Times

| Indicator | Yesterday | Same Day Last Week |
|---------------------------------|-----------|--------------------|
| ATM PVC Peak Utilization Hour | 9:00 | 4:00 |
| FR PVC Peak FR Utilization Hour | 20:00 | 19:00 |

Key Performance Indicators

Yesterday: Feb 28 1999 Last Week: Feb 21 1999 Last Month: Feb 1999

| Category | Technology | Indicator | Yesterday | Weekly Change | Monthly Change |
|------------|------------|--|----------------|---------------|----------------|
| Capacity | ATM | ATM Facility Booked Capacity | 77.69% | 0.00% | 0.00% |
| | | ATM Facility Total Capacity | 7,670,000,000 | 36.96% | 5.36% |
| | | ATM Fractional Facility Booked Capacity | 82.43% | -7.83% | -3.51% |
| | | ATM Fractional Facility Total Capacity | 102,000,000 | 0.00% | -96.43% |
| | FR | FR Facility Booked Capacity | 58.25% | 0.00% | -96.43% |
| | | FR Facility Total Capacity | 5,120,000 | 0.00% | -96.43% |
| | TDM | TDM Access Point Booked Capacity | 65.00% | 0.00% | 0.00% |
| | | TDM Access Point Total Capacity | 1,280,000,000 | 0.00% | -96.43% |
| | | TDM Facility Booked Capacity | 65.00% | 0.00% | 0.00% |
| | | TDM Facility Total Capacity | 1,280,000,000 | 0.00% | -96.43% |
| Congestion | FR | FR PVC Frames with BECN Bit Set | 936,216,235 | -4.80% | -96.50% |
| | | FR PVC Frames with FECN Bit Set | 978,551,593 | 1.77% | -96.37% |
| Load | ATM | ATM PVC ABR Ingress Cell Total | 1,566,714,914 | 2.96% | -96.36% |
| | | ATM PVC Average Utilization at Peak Util. Interval | 95.39% | -0.01% | |
| | | ATM PVC CBR Ingress Cell Total | 1,505,787,487 | -1.53% | -96.49% |
| | | ATM PVC Ingress Cell Policing Discards CLP=0 | 768,110,116 | -0.26% | -96.43% |
| | | ATM PVC Ingress Cell Policing Discards CLP=0+1 | 775,335,830 | 0.53% | -96.39% |
| | | ATM PVC UBR Ingress Cell Total | 1,412,646,991 | -1.04% | -96.50% |
| | | ATM PVC VBR Ingress Cell Total | 1,529,468,824 | -0.95% | -96.45% |
| | | FR PVC Average Utilization at Peak Util. Interval | 16.16% | -4.96% | |
| | | FR PVC Ingress Byte Total | 32,256,926,969 | 3.14% | -96.76% |
| | | FR PVC Ingress Frame Total | 957,026,862 | -2.36% | -96.44% |
| | FR | ATM PVC Cell Loss Ratio | 49.98% | 1.48% | 0.59% |
| | | FR Access Point Frame Congestion Discards DE Clear | 970,970,191 | 0.53% | -96.39% |
| | FR | FR PVC Frame Loss Ratio | 0.38% | -81.44% | 121.35% |
| | | FR PVC Frame Loss Ratio | 0.38% | -81.44% | 121.35% |
| Policing | ATM | ATM PVC ABR Tagged Ingress Cell Total | 20,098,735 | 5.40% | -95.64% |
| | | ATM PVC CBR Tagged Ingress Cell Total | 45,914,641 | 1729.42% | -93.52% |
| | | ATM PVC CLP=1 Ingress Cell % | 2.37% | 57.96% | -66.69% |
| | | ATM PVC UBR Tagged Ingress Cell Total | 117,950,350 | 12.92% | -95.46% |
| | | ATM PVC VBR Tagged Ingress Cell Total | 4,726,828 | -72.31% | -98.70% |
| | FR | FR Access Point Frame Congestion Discards DE Set | 978,654,252 | 1.24% | -96.36% |
| | | FR PVC % Network Tagged Frames | 90.48% | -7.65% | -9.17% |
| | | FR PVC Frames DE Set Total | 961,590,239 | 0.13% | -96.41% |
| | | FR PVC Frames DE Set Total | 961,590,239 | 0.13% | -96.41% |
| | | FR PVC Frames DE Set Total | 961,590,239 | 0.13% | -96.41% |

FIG. 3

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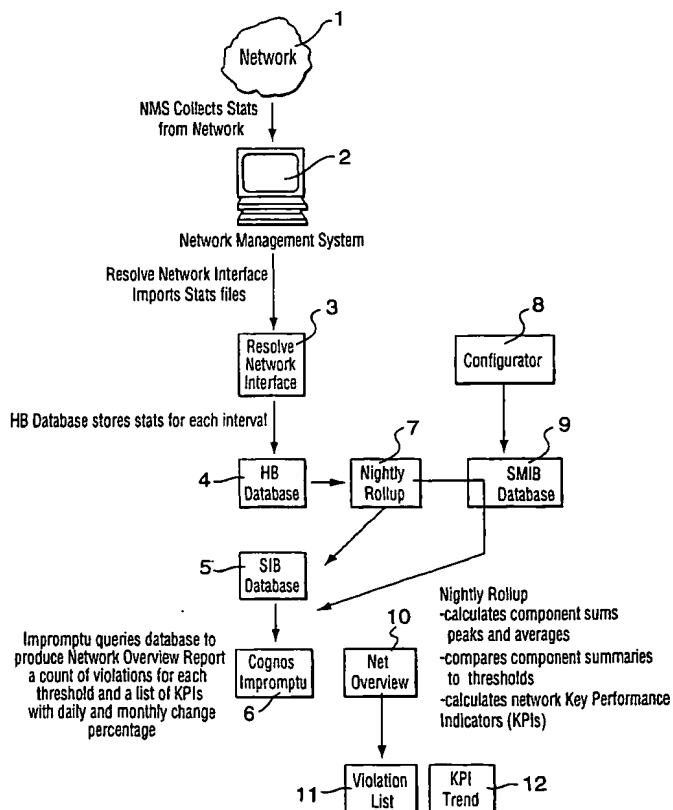
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(54) Title: NETWORK OVERVIEW REPORT



(57) Abstract: A method of identifying and locating performance issues in multi-technology wide area networks, involves monitoring individual components in the network to identify specific components whose performance has fallen below a predetermined threshold, and monitoring the aggregate performance of the network to create key performance indicators (KPIs) representative of the performance of the network as a whole. The threshold crossings and KPIs are displayed in a network overview report.

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A. CLASSIFICATION OF SUBJECT MATTER
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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

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12 March 2002

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

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| Patent document cited in search report | | Publication date | Patent family member(s) | Publication date |
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